

The NASA QBed: A Prototype Differentiated Services Network

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Outline

- Introduction
- Testbed Infrastructure
- Activities
- Summary

Introduction

- NASA serves international scientific research community
 - Close working relationships with NASA
 - EOS Instrument team members receive QA data from instruments on-board spacecraft
 - Science community requires data sets
 - NASA generated EOS science data sets open and available to public
- Most scientists located in academic and government institutions
 - Many served by advanced networks
 - vBNS, Abilene, ATDnet

Introduction

- NREN is a member of Internet2
- NASA's Earth Observing System (EOS) a major NASA network user
 - Daily movement of several terabytes of data
- NREN partnering with ESDIS in prototyping QoS

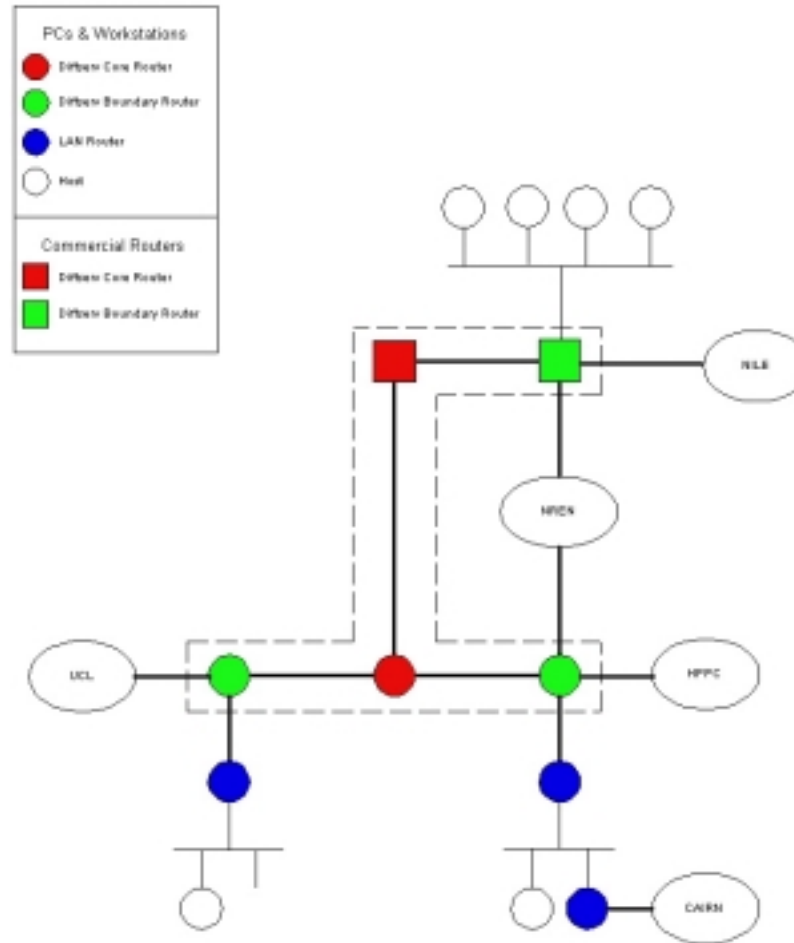
Introduction

- NASA QBed prototypes emerging QoS network technologies
 - Deploy QoS technologies
 - Demonstrate operational capabilities
 - Test high-end applications
 - Facilitate deployment of new technologies into operations networks

Testbed Infrastructure

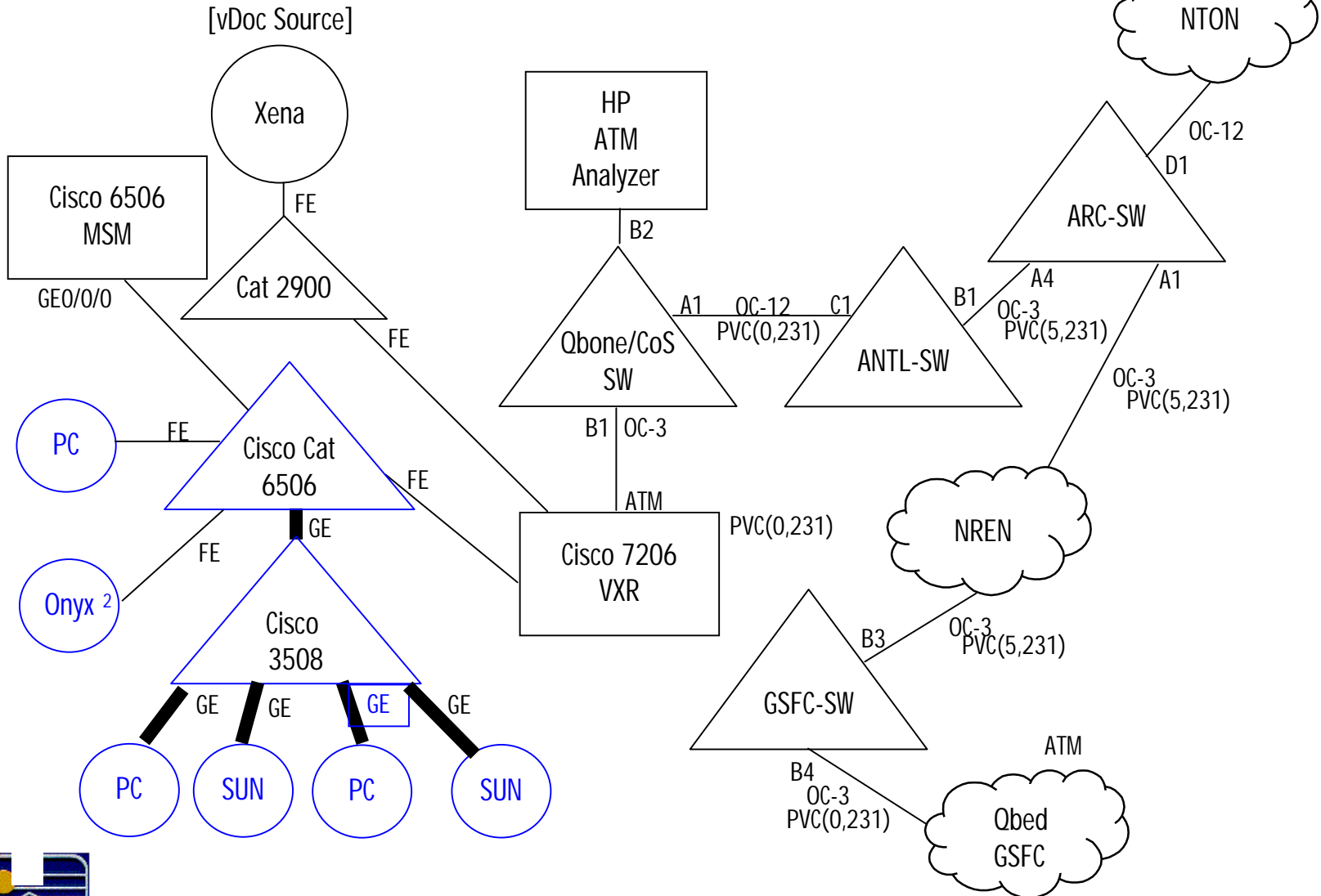
- ESDIS Network Prototyping Lab (ENPL) QBed site a heterogeneous network
 - Mostly Intel-based PCs running FreeBSD with ALTQ queuing subsystem
 - ALTQ - developed by Kenjiro Cho of Sony-Japan.
 - www.csl.sony.co.jp/person/kjc/programs.html
 - Two Cisco 7507 routers
 - Cisco 6500 series switch this year
 - FORE ASX-1000 ATM switch
 - Cisco FE, GE switches

Testbed Infrastructure



Current ENPL Topology

Testbed Infrastructure



Current NREN/ARC Topology

Testbed Infrastructure

- DiffServ-enabled backbone
 - OC-3 ATM as layer 2 service
 - Traffic conditioned at boundaries
 - Best effort, EF and AF PHBs
- Stub LANs along boundaries
 - Stub LAN serviced by PC router running ALTQ CBQ to optionally pre-condition traffic prior to entry into DiffServ backbone

Testbed Infrastructure

- Data generation tools
 - Unicast
 - ttcp
 - netperf
 - gen_send/ gen_receive
 - Chariot
 - Multicast
 - mgen
 - Chariot

Testbed Infrastructure

- Performance measurement tools
 - Host-based tools measure microflow performance
 - mgen , tdg, netperf` ttcp
 - throughput, rtt, delay, packet loss, jitter
 - Router-based tools monitor DiffServ performance
 - ttt, ALTQ and ENPL ttt derivatives; MRTG
 - monitor traffic conditioner and PHB performance
 - ttt and NeTraMet measure throughput
 - Need DiffServ monitoring/diagnostic tools for Cisco devices

Activities

- Current applications being tested
 - Audio/Video
 - vic/vat for multicast
 - Multicast NASA TV feed, peak to 5 Mbps
 - NREN's VCC to be installed
 - Peak to 30 Mbps
 - Multicast
 - mgen to emulate satellite telemetry streams
 - High-rate Data Transfer
 - ftp, ttcp, netperf, peak to near OC-3 line speed

Activities

- Capabilities Demonstration
 - Preferred traffic
 - Video and Audio multicast
 - Transmitted between 3 - 5 Mbps
 - High-rate TCP stream
 - Transmitted at 55 Mbps
 - Congesting traffic
 - High-rate UDP traffic at
 - Transmitted at 40 Mbps

Activities

- Capabilities Demonstration
 - Performance Measurements
 - Taken at all router interfaces
 - Traffic conditioning
 - boundary router ingress interface
 - PHB performance in interior
 - boundary router and interior router egress interface
 - Graphs show performance
 - MRTG over long periods
 - data capture at 5-minute intervals
 - ttt derivatives over 5-minute windows
 - data capture at 1-second intervals

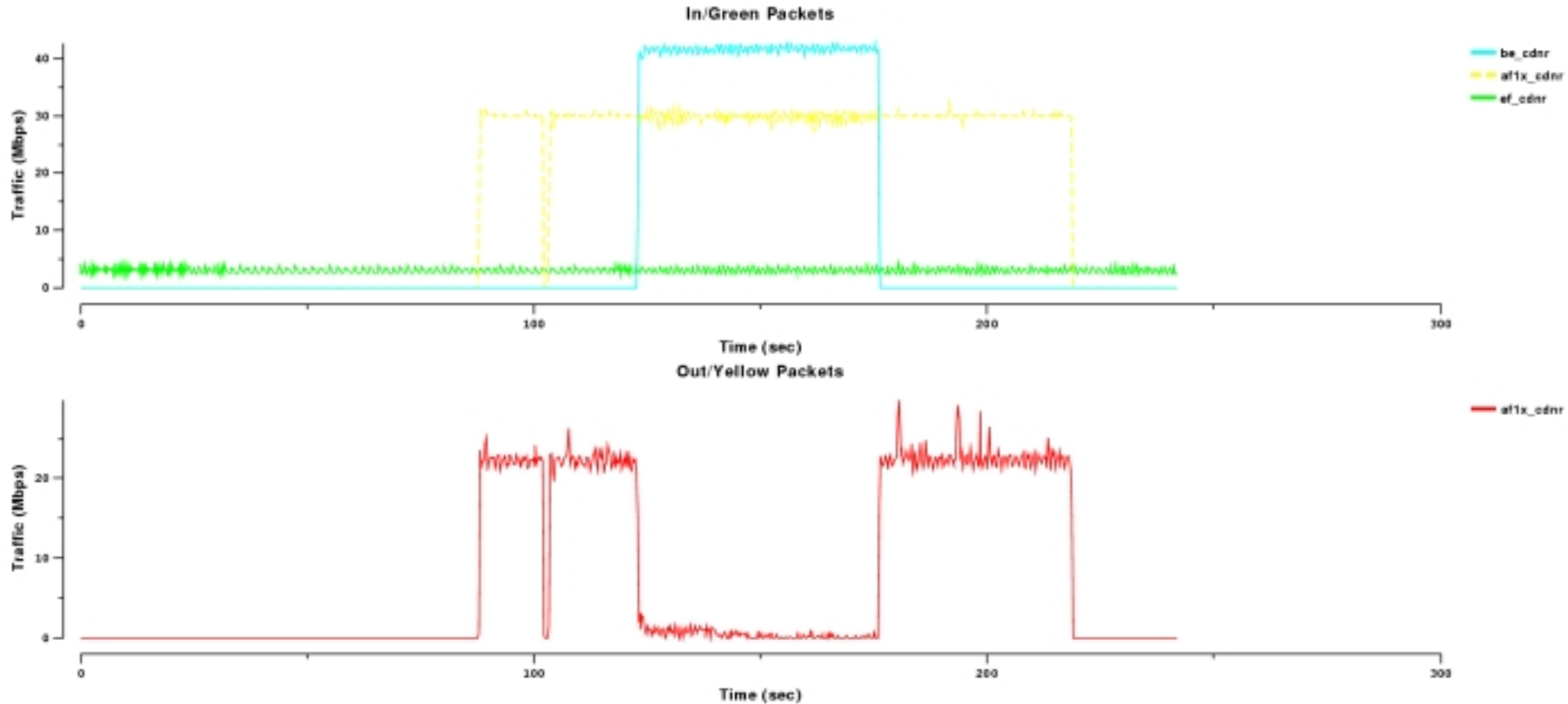
Activities

- Capabilities Demonstration
 - Configuration
 - Premium service for Video/Audio Multicast
 - Traffic conditioning uses token bucket meter
 - Service built on EF PHBs using CBQ
 - Preferred service for TCP traffic
 - Traffic conditioning uses 2-rate, 3-color marker
 - Service built on AF PHB using CBQ/RIO
 - Best Effort
 - Traffic conditioning uses token bucket meter
 - Best Effort forwarding uses CBQ to limit traffic

Activities

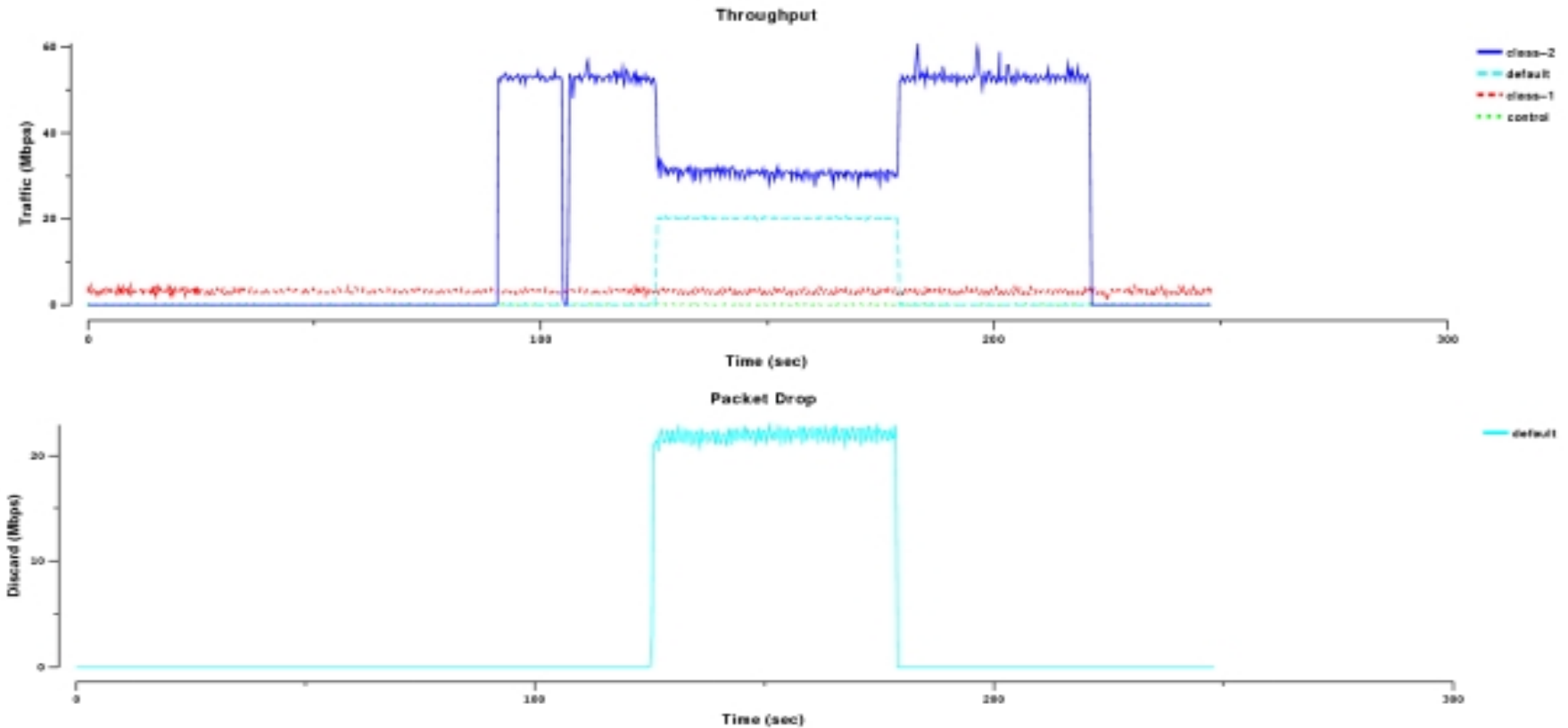
- Capabilities Demonstration
 - ATM PVC Configuration
 - ENPL routers equipped with OC-3 ATM NICs
 - With IP, effective throughput at 128 Mbps over backbone
 - Each end of the PVC polices traffic at 64 Mbps
 - Fast Ethernet on LANs

- Capabilities Demonstration



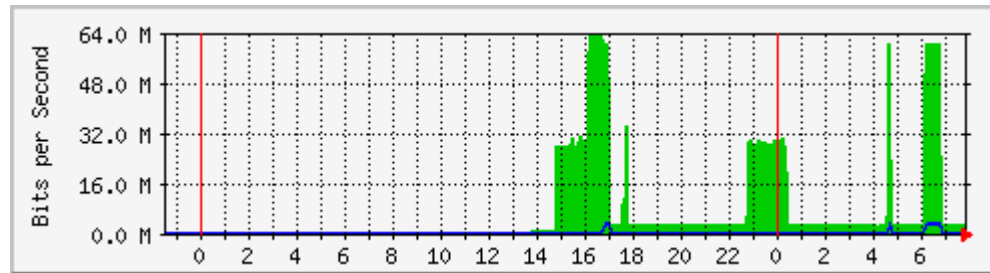
Traffic Conditioning on Ingress Interface of Boundary Router¹⁷

- Capabilities Demonstration

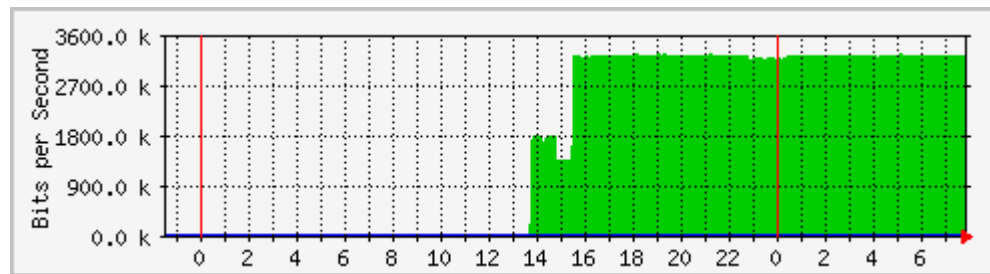


CBQ Performance Over Egress Interface Of A DiffServ Interior Router

- Capabilities Demonstration
 - Example MRTG graphs

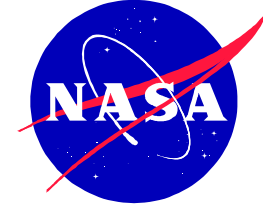


Traffic Conditioning: Marked/Passed Packets (green) vs. Dropped Packets (blue)



Traffic Forwarding: EF Packets Forwarded (green) vs. Packets Dropped (blue)

Activities



- Evaluating NTP performance over DiffServ
 - Mitigating impact of delay and jitter
- IP to ATM Class of Service Mapping
 - Uses ATM bundles
 - Map IP-based reserved flows to VBR/UBR
 - No noticeable performance hits
 - Bandwidth values consistent with normal sub-interfaces
 - Latency values consistent with normal sub-interfaces
 - Cisco IOS 12.0(5)XE and above (or a 12.05T and above branch)
- CAIRN Network Service Provider to UCL
 - Traffic mostly video teleconferencing



Activities

Spacecraft Clock and Data

- In summer 2000 ESDIS will test sending "Level One" (raw) space data over wide area TCP/IP
- Will use several research networks to send 50-70 Mb/sec.
- Will use DiffServ code point set in the application to insure service levels across domains

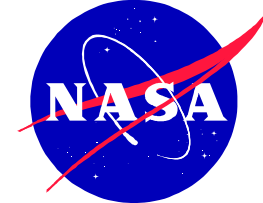
Activities

- Principal NASA partners
 - NREN at Ames Research Center (ARC)
 - ENPL at Goddard Space Flight Center (GSFC)
 - Also HECN and NILE labs
- External partners
 - Broadband and Wireless Networking Laboratory at Georgia Tech
 - University College London (UCL)

Activities

- Future Activities
 - Expansion of the QBed
 - peer with Abilene at ARC and GSFC
 - Enable Cisco DiffServ QoS
 - Prototyping Bandwidth Brokers
 - End-to-end QoS
 - RSVP
 - Prototyping MPLS
 - Integrate with DiffServ
 - NGI applications testing

Summary



- NASA QBed prototypes emerging QoS technologies
- Prototype QoS solutions for NGI applications and high-end NASA network requirements
- Facilitate deployment of advanced technologies to operational networks
- Web pages
 - <http://corn.eos.nasa.gov>
 - <http://www.nren.nasa.gov/eng/qos.html>
 - <http://www.ece.gatech.edu/research/labs/bwn>
 - <http://everest.gsfc.nasa.gov>
 - <http://nileweb.gsfc.nasa.gov>
 - <http://www.mice.cs.ucl.ac.uk/multimedia>

